PATENT ABSTRACTS OF JAPAN

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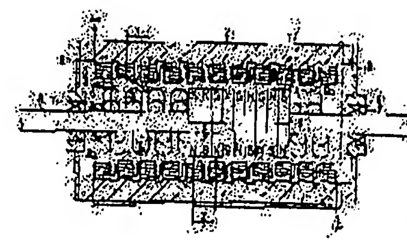
(54) LINEAR MOTOR

(57)Abstract:
PURPOSE: To make a movement pitch fine in the direction of an output axis by a method wherein magnetic poles which are installed on the inner circumferential face of a stator and individual phase of which are adjacent to each other in the circumferential direction are arranged so as to be shifted in the axial direction.



CONSTITUTION: A stator 2 is installed in a linear motor 1. The stator 2 is formed to be a cylindrical shape, and a plurality of magnetic poles 3 are installed so as to protrude toward the center of the stator 2 on the inner circumferential face. The magnetic poles 3 are column-shaped, and they are arranged so as to be faced along the axial direction. Individual magnetic-pole ends (3a, 3b), (3c, 3d), (3e, 3f) in phases A, B, C are set at equal intervals at a prescribed interval X along the axial direction of the stator 2. In addition, exciting coils 4 are wound on the individual magnetic poles 3 in such a way that they are continued to the

opposite magnetic poles in the axial direction and that the individual opposite magnetic-pole ends (3a, 3b), (3c, 3d), (3e, 3f) are to be reverse polarities. In a rotor 9, a plurality of disk-shaped permanent magnets 9a whose half on the outer circumference is magnetized to be an S-pole and whose remaining half is magnetized to be an N-pole are arranged and installed in such a way that the alternately different magnetic poles are brought into contact.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the stepping motor to which rectilinear motion of the output shaft which supports Rota is carried out.
[0002]
[Description of the Prior Art] A grip, push, and actuation that is taken up and down repeat an object like human being's hand and a guide peg, and a motor hand or a robot hand is required. There is a motor indicated by JP,62-40052,A as a source of power for rectilinear motion.
[0003] This motor is equipped with the cylindrical shape-like stator and the magnetic pole which rolled the exiting coil according to the individual is prepared in that inner skin as a salient pole. The magnetic pole is prepared in cylindrical shape-like Rota as a salient pole also at the peripheral face. It inserts in concentric circular arrangement and Rota is combined with it so that a mutual magnetic pole may have a fixed gap in the centrum of a cylindrical shape-like stator. Rota -- an axial rectilinear motion -- the need -- it has the output shaft of sufficient die length, and rotation and shaft-orientations migration are supported free by the bearing the rotation which this output shaft prepared in the bracket of the both ends of a stator, and for skids.
[0004] The magnetic pole of the inner skin of a stator and the magnetic pole of the peripheral face of Rota are the arrangement which aligned in the direction of an axis regularly as a cylindrical shape-like salient pole in the pitch which divided the axis lay length equally, and are prepared as a thing of a configuration of having achieved individual independence.
[0005] He loops a magnetic pole around the coil for excitation, and is trying to take out rotation or the rectilinear motion of shaft orientations by said motor by performing energization control switched to this coil for excitation one by one.

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CLAIMS

[Claim(s)]
[Claim 1] The linear motor which shifted the magnetic pole of ****** each phase to the hoop direction of said stator to shaft orientations mutually, and arranged it in it in the linear motor which has the tubed stator equipped with the magnetic pole of each phase which set and arranged predetermined spacing in inner skin to the hoop direction, and the output shaft which supports Rota which established the magnetic south pole and magnetic N pole in the peripheral face by turns in accordance with shaft orientations, and said Rota.

[Translation done.]

shaft, without dropping torque.

[0012]

[Means for Solving the Problem] In order to solve the above-mentioned trouble, this invention shifted and arranged the magnetic pole of ****** each phase in the hoop direction of said stator to shaft orientations in the linear motor which has the tubed stator equipped with the magnetic pole of each phase which set and arranged predetermined spacing in inner skin to the hoop direction, and the output shaft which supports Rota which established the magnetic south pole and magnetic N pole in the peripheral face by turns in accordance with shaft orientations, and said Rota mutually.

[0013]

[Function] Thus, constituted this invention is that the magnetic pole of ****** each phase shifted to shaft orientations, and has been arranged in the hoop direction established in the inner skin of a stator, and it can make detailed the migration pitch of the shaft orientations of an output shaft, without dropping torque.

[0014]

[Example] Hereafter, one example of the linear motor which materialized this invention is explained according to drawing 1 - drawing 4.

[0015] The linear motor 1 of a three phase circuit (it is hereafter called an A phase, a B phase, and C phase) is shown in drawing 2. The stator 2 as a stator is formed in the linear motor 1. The stator 2 is carrying out the shape of a cylindrical shape, and two or more magnetic poles 3 protrude on the inner skin toward the core of a stator 2. The magnetic pole 3 is carrying out the shape of a cylindrical shape, and as shown in drawing 1, in accordance with shaft orientations, phase opposite was carried out and it is located in a line. In accordance with the shaft orientations of a stator 2, the pole tips 3a and 3b of an A phase, the pole tips 3c and 3d of a B phase, and the pole tips 3e and 3f of C phase are the predetermined spacing X, and are arranged at equal intervals. Moreover, the magnetic pole 3 of each phase is looped around the pole tips 3a and 3b of the A phase which an exiting coil 4 follows shaft orientations and the magnetic pole which carries out phase opposite, and carries out phase opposite, the pole tips 3c and 3d of a B phase, and the pole tips 3e and 3f of C phase so that it may become reversed polarity.

[0016] If the mutual physical relationship of the pole tip of each phase is explained in full detail, a B phase rotates clockwise 60 degrees from an A phase, and is arranged in the place of further predetermined gap deltaX (this example 1/3 of pitch X) perpendicular direction this side (drawing 1 right). It rotates clockwise 60 degrees from a B phase, and C phase is arranged in the place of further predetermined gap deltaX (this example 1/3 of pitch X)

[0006] Moreover, the motor which changes rotation of Rota into the rectilinear motion of the output shaft which supported Rota is indicated by JP,63-121466,A. Make this motor spiral-like arrangement and it establishes the south pole and N pole in the periphery of Rota by turns. The stator which contains this Rota has two or more salient poles where a coil is twisted around that inside. In accordance with the shaft orientations of the above-mentioned stator, it is prepared in these salient poles at equal intervals. The pitch of much pole tips The bearing supported for the output shaft which considered as the integral multiple of a pitch which meets the Rota shaft orientations between the ****** south pole and N pole along the spiral direction of the above-mentioned spiral-like arrangement, and supported above-mentioned Rota, enabling free rotation is made to penetrate the above-mentioned output shaft free [shaft-orientations slidi].

[0007] Such a motor is a magnetic-attraction operation with the pole tip of a salient pole, and the magnetic pole of Rota by switching in order excitation of the coil coiled around the salient pole, and whenever one step of Rota rotates, it can be moved to the Rota shaft orientations between the unlike poles which meet in the spiral direction of Rota.

[0008]

[Problem(s) to be Solved by the Invention] However, by the motor indicated by JP,62-40052,A, since the magnetic pole which looped around the coil for excitation is arranged by the straight line, the pitch of sliding of shaft orientations cannot be made below into the pitch of a magnetic pole. Although what is necessary is to make a magnetic pole small and just to make the pitch of a magnetic pole fine, in order to carry out minute rectilinear motion, there is a limit in making a magnetic pole small, and there is a limitation also in the pitch of a magnetic pole. Moreover, if a magnetic pole is made not much small, magnetic flux will become small and torque wil fall.

[0009] Moreover, since it is an invalid and magnetic flux becomes [the scope of magnetization] small small, near [most] the boundary of the magnetic pole of the south pole and N pole which were established in the periphery of Rota cannot raise torque by the motor indicated by JP,63-121466,A.

[0010] Moreover, although below the pitch of a magnetic pole can be slid by controlling the current passed in the coil for excitation around which the magnetic pole was generally looped, it is necessary to add a control circuit for control of a current and, and control cannot raise repeatability difficultly.

[0011] The purpose of this invention is to offer the linear motor which can make detailed the migration pitch of the shaft orientations of an output

perpendicular direction this side (drawing 1 right). Therefore, each magnetic pole 3 of an A phase, a B phase, and C phase is mutually located in the include angle of 60 degrees, and has predetermined gap deltaX in the shaft orientations of a stator 2.

[0017] Terminals 4a and 4b are formed in the exiting coil 4 of an A phase, and Terminals 4c and 4d are formed in the exiting coil 4 of a B phase, and Terminals 4e and 4f are formed in the exiting coil 4 of C phase. The current limiter which is not illustrated is connected and each terminals 4a, 4b, 4c, 4d, 4e, and 4f are excited by the bipolar drive method or the unipolar drive method.

[0018] In the shaft-orientations both ends of said stator 2, it has fixed so that the disc-like bearing bracket 5 may become the same as that of the core of a stator 2. The through tube 6 is formed in the core, the perimeter of a through tube 6 projects the bearing bracket 5 on the front reverse side of the bearing bracket 5, and it is formed. Bearing 7 is inserted in the through tube 6 of the bearing bracket 5. Bearing 7 supports an output shaft 8 pivotable and possible [axial directional movement]. . Rota 9 as a rotator has fixed to the output shaft 8. The output shaft 8 has penetrated Rota 9 so that the core may become the same as that of the core of Rota 9. It has sufficient die length which needs an output shaft 8 for Rota 9 to carry out axial rectilinear motion of the inside of a stator 2.

[0019] Rota 9 consists of two or more permanent magnet 9a of a disk configuration. And as for the one permanent magnet 9a, magnetization of the south pole and N pole is given to a peripheral face, and, as for the south pole and N pole, N pole is magnetized by the one half of a periphery in the south pole and the remaining one half. And adjoining permanent magnet 9a is arranged so that a mutually different magnetic pole may touch. Moreover, he is trying to set the thickness of permanent magnet 9a to one half of the pitches X of the magnetic pole 3 formed in the stator 2 by this example. Therefore, the pitch of the shaft orientations of the magnetic pole formed in Rota 9 is one half of the pitches X of the magnetic pole 3 which protruded on the stator 2.

[0020] Next, an operation of the linear motor 1 constituted in this way is explained using drawing 2 -4. In addition, drawing 3 and 4 put in order and showed the magnetic pole 3 of the expedient top of explanation, and each phase on the same straight line. The control to which an output shaft 8 is moved rightward is explained. A current is controlled so that pole tip 3a of the A phase of a linear motor 1 becomes N pole now. The magnetized south pole is lengthened by N pole of pole tip 3a, and stops Rota 9 in the place of magnetic flux where it increases most. Next, current control of an A phase is changed to a B phase, and a current is controlled so that pole tip 3c

becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9 as shown in drawing 3 , the south pole of Rota 9 currently lengthened by pole tip 3a stops in the place where N pole of pole tip 3c lengthens, and magnetic flux increases most. Since pole tip 3c rotated 60 degrees clockwise and is further shifted to the shaft-orientations right deltaX rather than pole tip 3a, only delta X moves Rota 9 to the shaft-orientations right while rotating 60 degrees clockwise.

[0021] Subsequently, current control of a B phase is changed to C phase, and a current is controlled so that pole tip 3e becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3c stops in the place where N pole of pole tip 3e lengthens, and magnetic flux increases most. Since pole tip 3c rotated 60 degrees clockwise and is further shifted to shaft orientations rather than pole tip 3b on deltaX right, only delta X moves and stops Rota 9 on the shaft-orientations right while rotating 60 degrees clockwise.

[0022] Furthermore, current control of C phase is changed to an A phase, and a current is controlled so that pole tip 3b becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3e stops in the place where N pole of pole tip 3b lengthens, and magnetic flux increases most. Since pole tip 3b rotated 60 degrees clockwise and is further shifted to shaft orientations rather than pole tip 3e on deltaX right, only delta X moves and stops Rota 9 on the shaft-orientations right while rotating 60 degrees clockwise.

[0023] Eight slides rightward an output shaft every X [delta] by changing the phase and excitation polarity which are excited as mentioned above one by one (for example, N pole being changed to pole tip 3a->3c->3e->3b->3d->3f->3a).

[0024] Contrary to the above, the control to which an output shaft 8 is moved leftward is explained. A current is controlled so that pole tip 3a of the A phase of a linear motor 1 becomes N pole now. The magnetized south pole is lengthened by N pole of pole tip 3a, and stops Rota 9 in the place of magnetic flux where it increases most. Next, current control of an A phase is changed to C phase, and 3f of pole tips controls a current to become N pole. Since the force F2 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3a stops in the place where N pole of 3f of pole tips lengthens, and magnetic flux increases most. Since it rotated 60 degrees counterclockwise and 3f of pole tips is further shifted to the shaft-orientations left deltaX rather than pole tip 3a, Rota 9 is moved to shaft orientations leftward [

deltaX] while rotating 60 degrees counterclockwise.

[0025] Subsequently, current control of C phase is changed to a B phase, and a current is controlled so that 3d of pole tips serves as N pole. Since the force F2 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by 3f of pole tips is lengthened by N pole which is 3d of pole tips, and stops in the place of magnetic flux where it increases most. Since it rotated 60 degrees counterclockwise and 3d of pole tips is further shifted to shaft orientations rather than 3f of pole tips on deltaX left, only delta X moves Rota 9 to the shaft-orientations left while rotating 60 degrees counterclockwise.

[0026] Subsequently, current control of a B phase is changed to an A phase, and a current is controlled so that pole tip 3b becomes N pole. Sinc the force F2 works in the direction which magnetic flux increases to Rota the south pole of Rota 9 currently lengthened by 3d of pole tips is lengthened by N pole of pole tip 3b, and stops in the place of magnetic flux where it increases most. Since pole tip 3b rotated 60 degrees counterclockwise and is further shifted to shaft orientations rather than 3d of pole tips on deltaX left, only delta X moves Rota 9 to the shaft-orientations left while rotating 60 degrees counterclockwise.

[0027] Eight moves leftward an output shaft every X [delta] by changing the excitation magnetic pole to the phase excited as mentioned above one by one (for example, N pole being changed to pole tip 3a->3f->3d->3b->3e->3c->3a).

[0028] Thus, in the linear motor of this example, migration finer than the pitch X of the magnetic pole 3 which formed the output shaft 8 in the shaft orientations of a stator 2 can be made into the shaft orientations of an output shaft 8 by having shifted deltaX and having arranged the magnetic pole 3 of ****** each phase to the shaft orientations of a stator 2, in the hoop direction of a stator 2. Moreover, since it is not necessary to make a magnetic pole 3 small to the migration pitch of an output shaft 8 by having shifted to shaft orientations deltaX and having formed the magnetic pole 3 of each phase, the magnitude of magnetic flux does not change and torque does not fall.

[0029] In addition, you may make it this invention be the following in the range which is not limited to the above-mentioned example and does not deviate from the meaning of this invention.

(1) Although the exiting coil of a three phase circuit was used in the above-mentioned example, it is good also as an exiting coil of with a phases of two or more two or more phases. Moreover, as shown in drawing 5 , you may wind for every magnetic pole.

[0030] (2) Although magnetization of the hoop direction in Rota is performed

in the above-mentioned example every [of a periphery / 2 / 1/], a periphery may be divided into plurality and the south pole and N pole may be magnetized by turns. Moreover, as shown in drawing 6 , all peripheries may be magnetized to the south pole (or N pole).

[0031] (3) Although the cylinder-like thing was used as Rota in the above-mentioned example, things other than a cylinder (a periphery is a hexagon-like cylinder) may be used.

(4) Although two or more permanent magnets of a disk configuration were used for Rota in the above-mentioned example, package formation may be carried out with a cylinder-like permanent magnet.

[0032]

[Effect of the Invention] The outstanding effectiveness that the migration pitch of the shaft orientations of an output shaft can be made detailed is done so, without dropping torque on according to the linear motor of this invention, the magnetic pole of ****** each phase having shifted to shaft orientations, and having been arranged in the hoop direction established in the inner skin of a stator, as explained in full detail above.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A grip, push, and actuation that is taken up and down repeat an object like human being's hand and a guide peg, and a motor hand or a robot hand is required. There is a motor indicated by JP,62-40052,A as a source of power for rectilinear motion.
[0003] This motor is equipped with the cylindrical shape-like stator and the magnetic pole which rolled the exiting coil according to the individual is prepared in that inner skin as a salient pole. The magnetic pole is prepared in cylindrical shape-like Rota as a salient pole also at the peripheral face. It inserts in concentric circular arrangement and Rota is combined with it so that a mutual magnetic pole may have a fixed gap in the centrum of a cylindrical shape-like stator. Rota -- an axial rectilinear motion -- the need -- it has the output shaft of sufficient die length, and rotation and shaft-orientations migration are supported free by the bearing the rotation which this output shaft prepared in the bracket of the both ends of a stator, and for skids.
[0004] The magnetic pole of the inner skin of a stator and the magnetic pole of the peripheral face of Rota are the arrangement which aligned in the direction of an axis regularly as a cylindrical shape-like salient pole in the pitch which divided the axis lay length equally, and are prepared as a thing of a configuration of having achieved individual independence.
[0005] He loops a magnetic pole around the coil for excitation, and is trying to take out rotation or the rectilinear motion of shaft orientations by said motor by performing energization control switched to this coil for excitation one by one.
[0006] Moreover, the motor which changes rotation of Rota into the rectilinear motion of the output shaft which supported Rota is indicated by JP,63-121466,A. Make this motor spiral-like arrangement and it establishes the south pole and N pole in the periphery of Rota by turns. The stator which contains this Rota has two or more salient poles where a coil is

TECHNICAL FIELD

[Industrial Application] This invention relates to the stepping motor to which rectilinear motion of the output shaft which supports Rota is carried out.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] The outstanding effectiveness that the migration pitch of the shaft orientations of an output shaft can be made detailed is done so, without dropping torque on according to the linear motor of this invention, the magnetic pole of ****** each phase having shifted to shaft orientations, and having been arranged in the hoop direction established in the inner skin of a stator, as explained in full detail above.

[Translation done.]

twisted around that inside. In accordance with the shaft orientations of the above-mentioned stator, it is prepared in these salient poles at equal intervals. The pitch of much pole tips The bearing supported for the output shaft which considered as the integral multiple of a pitch which meets the Rota shaft orientations between the ****** south pole and N pole along the spiral direction of the above-mentioned spiral-like arrangement, and supported above-mentioned Rota, enabling free rotation is made to penetrate the above-mentioned output shaft free [shaft-orientations sliding].

[0007] Such a motor is a magnetic-attraction operation with the pole tip of a salient pole, and the magnetic pole of Rota by switching in order excitation of the coil coiled around the salient pole, and whenever one step of Rota rotates, it can be moved to the Rota shaft orientations between the unlike poles which meet in the spiral direction of Rota.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to solve the above-mentioned trouble, this invention shifted and arranged the magnetic pole of ****** each phase in the hoop direction of said stator to shaft orientations in the linear motor which has the tubed stator equipped with the magnetic pole of each phase which set and arranged predetermined spacing in inner skin to the hoop direction, and the output shaft which supports Rota which established the magnetic south pole and magnetic N pole in the peripheral face by turns in accordance with shaft orientations, and said Rota mutually.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, by the motor indicated by JP,62-40052,A, since the magnetic pole which looped around the coil for excitation is arranged by the straight line, the pitch of sliding of shaft orientations cannot be made below into the pitch of a magnetic pole. Although what is necessary is to make a magnetic pole small and just to make the pitch of a magnetic pole fine, in order to carry out minute rectilinear motion, there is a limit in making a magnetic pole small, and there is a limitation also in the pitch of a magnetic pole. Moreover, if a magnetic pole is made not much small, magnetic flux will become small and torque will fall.
[0009] Moreover, since it is an invalid and magnetic flux becomes [the scope of magnetization] small small, near [most] the boundary of the magnetic pole of the south pole and N pole which were established in the periphery of Rota cannot raise torque by the motor indicated by JP,63-121466,A.
[0010] Moreover, although below the pitch of a magnetic pole can be slid by controlling the current passed in the coil for excitation around which the magnetic pole was generally looped, it is necessary to add a control circuit for control of a current and, and control cannot raise repeatability difficultly.
[0011] The purpose of this invention is to offer the linear motor which can make detailed the migration pitch of the shaft orientations of an output shaft, without dropping torque.

[Translation done.]

EXAMPLE

[Example] Hereafter, one example of the linear motor which materialized this invention is explained according to drawing 1 - drawing 4 .
[0015] The linear motor 1 of a three phase circuit (it is hereafter called an A phase, a B phase, and C phase) is shown in drawing 2 . The stator 2 as a stator is formed in the linear motor 1. The stator 2 is carrying out the shape of a cylindrical shape, and two or more magnetic poles 3 protrude on the inner skin toward the core of a stator 2. The magnetic pole 3 is carrying out the shape of a cylindrical shape, and as shown in drawing 1 , in accordance with shaft orientations, phase opposite was carried out and it is located in a line. In accordance with the shaft orientations of a stator 2, the pole tips 3a and 3b of an A phase, the pole tips 3c and 3d of a B phase, and the pole tips 3e and 3f of C phase are the predetermined spacing X, and are arranged at equal intervals. Moreover, the magnetic pole 3 of each phase is looped around the pole tips 3a and 3b of the A phase which an exiting coil 4 follows shaft orientations and the magnetic pole which carries out phase opposite, and carries out phase opposite, the pole tips 3c and 3d of a B phase, and the pole tips 3e and 3f of C phase so that it may become reversed polarity.
[0016] If the mutual physical relationship of the pole tip of each phase is explained in full detail, a B phase rotates clockwise 60 degrees from an A phase, and is arranged in the place of further predetermined gap deltaX (this example 1/3 of pitch X) perpendicular direction this side (drawing 1 right). It rotates clockwise 60 degrees from a B phase, and C phase is arranged in the place of further predetermined gap deltaX (this example 1/3 of pitch X) perpendicular direction this side (drawing 1 right). Therefore, each magnetic pole 3 of an A phase, a B phase, and C phase is mutually located in the include angle of 60 degrees, and has predetermined gap deltaX in the shaft orientations of a stator 2.
[0017] Terminals 4a and 4b are formed in the exiting coil 4 of an A phase,

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OPERATION

[Function] Thus, constituted this invention is that the magnetic pole of ****** each phase shifted to shaft orientations, and has been arranged in the hoop direction established in the inner skin of a stator, and it can make detailed the migration pitch of the shaft orientations of an output shaft, without dropping torque.

[Translation done.]

deltaX rather than pole tip 3a, only delta X moves Rota 9 to the shaft-orientations right while rotating 60 degrees clockwise.

[0021] Subsequently, current control of a B phase is changed to C phase, and a current is controlled so that pole tip 3e becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3c stops in the place where N pole of pole tip 3e lengthens, and magnetic flux increases most. Since pole tip 3c rotated 60 degrees clockwise and is further shifted to shaft orientations rather than pole tip 3b on deltaX right, only delta X moves and stops Rota 9 on the shaft-orientations right while rotating 60 degrees clockwise.

[0022] Furthermore, current control of C phase is changed to an A phase, and a current is controlled so that pole tip 3b becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3e stops in the place where N pole of pole tip 3b lengthens, and magnetic flux increases most. Since pole tip 3b rotated 60 degrees clockwise and is further shifted to shaft orientations rather than pole tip 3e on deltaX right, only delta X moves and stops Rota 9 on the shaft-orientations right while rotating 60 degrees clockwise.

[0023] Eight slides rightward an output shaft every X [delta] by changing the phase and excitation polarity which are excited as mentioned above one by one (for example, N pole being changed to pole tip 3a->3c->3e->3b->3d->3f->3a).

[0024] Contrary to the above, the control to which an output shaft 8 is moved leftward is explained. A current is controlled so that pole tip 3a of the A phase of a linear motor 1 becomes N pole now. The magnetized south pole is lengthened by N pole of pole tip 3a, and stops Rota 9 in the place of magnetic flux where it increases most. Next, current control of an A phase is changed to C phase, and 3f of pole tips controls a current to become N pole. Since the force F2 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by pole tip 3a stops in the place where N pole of 3f of pole tips lengthens, and magnetic flux increases most. Since it rotated 60 degrees counterclockwise and 3f of pole tips is further shifted to the shaft-orientations left deltaX rather than pole tip 3a, Rota 9 is moved to shaft orientations leftward [deltaX] while rotating 60 degrees counterclockwise.

[0025] Subsequently, current control of C phase is changed to a B phase, and a current is controlled so that 3d of pole tips serves as N pole. Since the force F2 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by 3f of pole tips is

and Terminals 4c and 4d are formed in the exiting coil 4 of a B phase, and Terminals 4e and 4f are formed in the exiting coil 4 of C phase. The current limiter which is not illustrated is connected and each terminals 4a, 4b, 4c, 4d, 4e, and 4f are excited by the bipolar drive method or the unipolar drive method.

[0018] In the shaft-orientations both ends of said stator 2, it has fixed so that the disc-like bearing bracket 5 may become the same as that of the core of a stator 2. The through tube 6 is formed in the core, the perimeter of a through tube 6 projects the bearing bracket 5 on the front reverse side of the bearing bracket 5, and it is formed. Bearing 7 is inserted in the through tube 6 of the bearing bracket 5. Bearing 7 supports an output shaft 8 pivotable and possible [axial directional movement]. . Rota 9 as a rotat has fixed to the output shaft 8. The output shaft 8 has penetrated Rota 9 so that the core may become the same as that of the core of Rota 9. It has sufficient die length which needs an output shaft 8 for Rota 9 to carry out axial rectilinear motion of the inside of a stator 2.

[0019] Rota 9 consists of two or more permanent magnet 9a of a disk configuration. And as for the one permanent magnet 9a, magnetization of the south pole and N pole is given to a peripheral face, and, as for the south pole and N pole, N pole is magnetized by the one half of a periphery in the south pole and the remaining one half. And adjoining permanent magnet 9a is arranged so that a mutually different magnetic pole may touch. Moreover, he is trying to set the thickness of permanent magnet 9a to one half of the pitches X of the magnetic pole 3 formed in the stator 2 by this example. Therefore, the pitch of the shaft orientations of the magnetic pole formed in Rota 9 is one half of the pitches X of the magnetic pole 3 which protruded on the stator 2.

[0020] Next, an operation of the linear motor 1 constituted in this way is explained using drawing 2 -4. In addition, drawing 3 and 4 put in order and showed the magnetic pole 3 of the expedient top of explanation, and each phase on the same straight line. The control to which an output shaft 8 is moved rightward is explained. A current is controlled so that pole tip 3a of the A phase of a linear motor 1 becomes N pole now. The magnetized south pole is lengthened by N pole of pole tip 3a, and stops Rota 9 in the place of magnetic flux where it increases most. Next, current control of an A phase is changed to a B phase, and a current is controlled so that pole tip 3c becomes N pole. Since the force F1 works in the direction which magnetic flux increases to Rota 9 as shown in drawing 3 , the south pole of Rota 9 currently lengthened by pole tip 3a stops in the place where N pole of pole tip 3c lengthens, and magnetic flux increases most. Since pole tip 3c rotated 60 degrees clockwise and is further shifted to the shaft-orientations right

lengthened by N pole which is 3d of pole tips, and stops in the place of magnetic flux where it increases most. Since it rotated 60 degrees counterclockwise and 3d of pole tips is further shifted to shaft orientations rather than 3f of pole tips on deltaX left, only delta X moves Rota 9 to the shaft-orientations left while rotating 60 degrees counterclockwise.
[0026] Subsequently, current control of a B phase is changed to an A phase, and a current is controlled so that pole tip 3b becomes N pole. Since the force F2 works in the direction which magnetic flux increases to Rota 9, the south pole of Rota 9 currently lengthened by 3d of pole tips is lengthened by N pole of pole tip 3b, and stops in the place of magnetic flux where it increases most. Since pole tip 3b rotated 60 degrees counterclockwise and is further shifted to shaft orientations rather than 3d of pole tips on deltaX left, only delta X moves Rota 9 to the shaft-orientations left while rotating 60 degrees counterclockwise.
[0027] Eight moves leftward an output shaft every X [delta] by changing the excitation magnetic pole to the phase excited as mentioned above one by one (for example, N pole being changed to pole tip 3a->3f->3d->3b->3e->3c->3a).
[0028] Thus, in the linear motor of this example, migration finer than the pitch X of the magnetic pole 3 which formed the output shaft 8 in the shaft orientations of a stator 2 can be made into the shaft orientations of an output shaft 8 by having shifted deltaX and having arranged the magnetic pole 3 of ****** each phase to the shaft orientations of a stator 2, in the hoop direction of a stator 2. Moreover, since it is not necessary to make a magnetic pole 3 small to the migration pitch of an output shaft 8 by having shifted to shaft orientations deltaX and having formed the magnetic pole 3 of each phase, the magnitude of magnetic flux does not change and torque does not fall.
[0029] In addition, you may make it this invention be the following in the range which is not limited to the above-mentioned example and does not deviate from the meaning of this invention.
(1) Although the exiting coil of a three phase circuit was used in the above-mentioned example, it is good also as an exiting coil of with a phases of two or more two or more phases. Moreover, as shown in drawing 5 , you may wind for every magnetic pole.
[0030] (2) Although magnetization of the hoop direction in Rota is performed in the above-mentioned example every [of a periphery / 2 / 1/], a periphery may be divided into plurality and the south pole and N pole may be magnetized by turns. Moreover, as shown in drawing 6 , all peripheries may be magnetized to the south pole.(or N pole).
[0031] (3) Although the cylinder-like thing was used as Rota in the

above-mentioned example, things other than a cylinder (a periphery is a hexagon-like cylinder) may be used.
(4) Although two or more permanent magnets of a disk configuration were used for Rota in the above-mentioned example, package formation may be carried out with a cylinder-like permanent magnet.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing of longitudinal section showing the example of this invention.
[Drawing 2] It is the cross-sectional view showing the example of this invention.
[Drawing 3] It is drawing of longitudinal section showing an operation of the right translation of Rota.
[Drawing 4] It is drawing of longitudinal section showing an operation of the left translation of Rota.
[Drawing 5] It is drawing of longitudinal section showing the linear motor of example of another.
[Drawing 6] It is the perspective view showing Rota of example of another.
[Description of Notations]
1 [-- An exiting coil, 8 / -- An output shaft, 9 / -- Rota] -- A linear motor, 2 -- A stator, 3 -- A magnetic pole, 4

[Translation done.]

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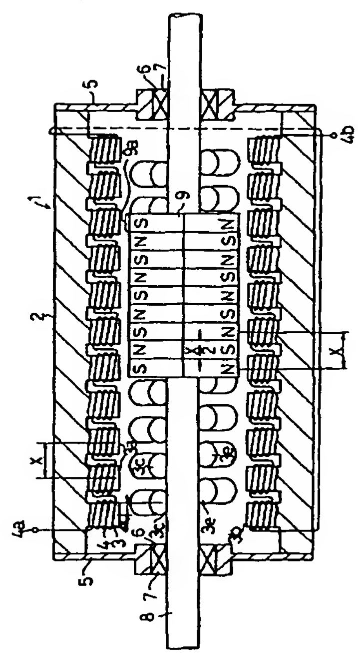
(54)【発明の名称】　リニアモータ

(57)【要約】
【目的】　出力軸の軸方向の移動を微細化する。
【構成】３相のリニアモータ１には固定子であるステータ２と回転子であるロータ９が設けられている。ステータ２は円筒形状をしており、その内周面には３相の励磁コイル４が巻装された円柱形状の磁極３がステータ２の中心に向かって突設されている。各相の磁極３はステータ２の軸方向に沿って所定の間隔Ｘで等間隔に配設されており、周方向に隣合う各相の磁極３は軸方向に所定の距離ΔＸずれている。ロータ９は外周の半分にＳ極，残り半分にＮ極が着磁された円盤形状の複数の永久磁石９ａが互いに異なる磁極が接するように配設されている。励磁コイル４の励磁を順次切り替えることにより、ロータ９に支持する出力軸８を微小移動させることができる。



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【特許請求の範囲】

【請求項１】内周面に、周方向に対して所定間隔をおいて配設した各相の磁極を備えた筒状のステータと、
外周面に軸方向に沿って磁石のＳ極とＮ極を交互に設けたロータと前記ロータを支持する出力軸とを有するリニアモータにおいて、
前記ステータの周方向に隣合う各相の磁極を互いに軸方向に対してずらして配設したリニアモータ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明はロータを支持する出力軸を直線運動させるステッピングモータに関するものである。

【０００２】

【従来の技術】モータハンドあるいはロボットハンドなどは、人間の手，足と同様に物をつかみ，押し，上げ下げするような動作が繰り返し要求される。直線運動用の動力源として、例えば特開昭６２－４００５２に開示されたモータがある。

【０００３】このモータは円筒形状のステータを備えており、その内周面には個別に励磁コイルを巻いた磁極が突極として設けられている。円柱形状のロータには、その外周面にも磁極が突極として設けられている。ロータは、円筒形状のステータの中空部内に、相互の磁極が一定のギャップをもつように同心円状配置に挿入して組み合わされている。ロータは、軸直線運動に必要十分な長さの出力軸を有し、この出力軸がステータの両端部のブラケットに設けた回転及びすべり用の軸受けにより回転及び軸方向移動が自在に支持されている。

【０００４】ステータの内周面の磁極及びロータの外周面の磁極は、その軸線方向の長さを等分したピッチで円柱形状の突極として、軸線方向に規則正しく整列した配置で、かつ個々独立した構成のものとして設けられている。

【０００５】前記モータでは磁極に励磁用コイルを巻装し、この励磁用コイルに順次切り換える通電制御を行うことによって回転運動又は軸方向の直線運動を取り出すようにしている。

【０００６】又、ロータの回転運動をロータを支持した出力軸の直線運動に変換するモータが特開昭６３－１２１４６６に開示されている。このモータはロータの外周にＳ極とＮ極とをスパイラル状の配置にして交互に設け、このロータを収納するステータはその内面に巻線が巻き付けられる複数の突極を有し、これら突極に上記ステータの軸方向に沿って等間隔に設けられて多数の磁極端のピッチを、上記スパイラル状配置のスパイラル方向に沿って隣合うＳ極とＮ極との間のロータ軸方向に沿うピッチの整数倍とし、かつ、上記ロータを支持した出力軸を回転自在に支持する軸受に上記出力軸を軸方向摺動自在に貫通させたものである。

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【０００７】このようなモータは、突極に巻かれた巻線の励磁を順番に切り換えることにより、突極の磁極端とロータの磁極との磁気吸引作用で、ロータが１ステップ回転する毎に、ロータのスパイラル方向に沿う異極間のロータ軸方向に移動させることができる。

【０００８】

【発明が解決しようとする課題】ところが、特開昭６２－４００５２に開示されたモータでは励磁用コイルを巻装した磁極は直線に配列されているため、軸方向の摺動のピッチは磁極のピッチ以下にすることはできない。微小な直線運動をさせるためには磁極を小さくして磁極のピッチを細かくすれば良いが、磁極を小さくするには限度があり磁極のピッチにも限界がある。又、磁極をあまり小さくすると磁束が小さくなりトルクが落ちてしまう。

【０００９】又、特開昭６３－１２１４６６に開示されたモータではロータの外周に設けられたＳ極とＮ極の磁極の境界付近はほとんど無効であるので着磁の有効範囲が小さく磁束が小さくなるのでトルクを上げることはできない。

【００１０】又、一般に磁極に巻装された励磁用コイルに流す電流を制御することで磁極のピッチ以下に摺動させることができるが電流の制御のために制御回路を追加する必要があり、また制御が難しく繰り返し精度を高めることはできない。

【００１１】本発明の目的はトルクを落とすことなく出力軸の軸方向の移動ピッチを微細化することができるリニアモータを提供することにある。

【００１２】

【課題を解決するための手段】上記問題点を解決するために本発明は、内周面に、周方向に対して所定間隔をおいて配設した各相の磁極を備えた筒状のステータと、外周面に軸方向に沿って磁石のＳ極とＮ極を交互に設けたロータと前記ロータを支持する出力軸とを有するリニアモータにおいて、前記ステータの周方向に隣合う各相の磁極を互いに軸方向に対してずらして配設した。

【００１３】

【作用】このように構成された本発明は、ステータの内周面に設けた周方向に隣合う各相の磁極が軸方向にずれて配置されたことで、トルクを落とすことなく出力軸の軸方向の移動ピッチを微細化することができる。

【００１４】

【実施例】以下、本発明を具体化したリニアモータの一実施例を図１～図４に従って説明する。

【００１５】図２に３相（以下、Ａ相，Ｂ相，Ｃ相と呼ぶ）のリニアモータ１を示す。リニアモータ１には固定子としてのステータ２が設けられている。ステータ２は円筒形状をしており、その内周面には複数の磁極３がステータ２の中心に向かって突設されている。磁極３は円柱形状をしており、図１に示すように軸方向に沿って相

対向して並んでいる。A相の磁極端３ａ，３ｂ、B相の磁極端３ｃ，３ｄ、C相の磁極端３ｅ，３ｆはステータ２の軸方向に沿って所定の間隔Xで等間隔に配設されている。又、各相の磁極３には励磁コイル４が軸方向かつ相対向する磁極に連続し、相対向するA相の磁極端３ａ，３ｂ、B相の磁極端３ｃ，３ｄ、C相の磁極端３ｅ，３ｆは逆極性となるように巻装されている。

【００１６】各相の磁極端の互いの位置関係を詳述すると、B相はA相から６０度時計方向に回転し更に所定のずれΔX（本実施例ではピッチXの１／３）垂直方向手前（図１では右方向）の所に配設されている。C相はB相から６０度時計方向に回転し更に所定のずれΔX（本実施例ではピッチXの１／３）垂直方向手前（図１では右方向）の所に配設されている。従って、A相，B相とC相の各磁極３は互いに６０度の角度に位置し、ステータ２の軸方向に所定のずれΔXを有している。

【００１７】A相の励磁コイル４には端子４ａ，４ｂが設けられており、B相の励磁コイル４には端子４ｃ，４ｄが設けられており、又C相の励磁コイル４には端子４ｅ，４ｆが設けられている。各端子４ａ，４ｂ，４ｃ，４ｄ，４ｅ，４ｆは図示しない電流制御器が接続され、バイポーラ駆動方式またはユニポーラ駆動方式により励磁される。

【００１８】前記ステータ２の軸方向両端には円板状の軸受ブラケット５がステータ２の中心と同一となるように固着されている。軸受ブラケット５はその中心部に貫通孔６が設けられており、貫通孔６の周囲が軸受ブラケット５の表裏に突出して形成されている。軸受ブラケット５の貫通孔６には軸受７が挿着されている。軸受７は出力軸８を回転可能にかつ軸方向移動可能に支持するようになっている。。出力軸８には回転子としてのロータ９が固着されている。出力軸８はその中心がロータ９の中心と同一となるようにロータ９を貫通している。出力軸８はロータ９がステータ２中を軸直線運動するのに必要十分な長さを有している。

【００１９】ロータ９は円盤形状の複数の永久磁石９ａから構成されている。そして、その一つの永久磁石９ａは外周面にS極とN極の着磁が施され、S極とN極は外周の半分にS極，残り半分にN極が着磁されている。そして、隣接する永久磁石９ａは互いに異なる磁極が接するように配設されている。又、永久磁石９ａの厚さは本実施例ではステータ２に形成した磁極３のピッチXの１／２となるようにしている。従って、ロータ９に形成された磁極の軸方向のピッチはステータ２に突設された磁極３のピッチXの１／２となっている。

【００２０】次に、このように構成されたリニアモータ１の作用を図２～４を用いて説明する。尚、図３，４は説明の便宜上、各相の磁極３を同一直線上に並べて示した。出力軸８を右方向に移動させる制御について説明する。今、リニアモータ１のA相の磁極端３ａがN極となるように電流を制御する。ロータ９は着磁されたS極が磁極端３ａのN極に引かれて磁束の最も多くなる所で停止する。次に、A相の電流制御をB相に切り替え、磁極端３ｃがN極となるように電流を制御する。図３に示すようにロータ９には磁束が増加する方向に力F１が働くので、磁極端３ａに引かれていたロータ９のS極は磁極端３ｃのN極に引かれて磁束の最も多くなる所で停止する。磁極端３ｃは磁極端３ａよりも時計方向に６０度回転し更に軸方向右にΔXずれているので、ロータ９は時計方向に６０度回転するとともに軸方向右にΔXだけ移動する。

【００２１】次いで、B相の電流制御をC相に切り替え，磁極端３ｅがN極となるように電流を制御する。ロータ９には磁束が増加する方向に力F１が働くので磁極端３ｃに引かれていたロータ９のS極は磁極端３ｅのN極に引かれて磁束の最も多くなる所で停止する。磁極端３ｃは磁極端３ｂよりも時計方向に６０度回転し更に軸方向にΔX右にずれているので、ロータ９は時計方向に６０度回転するとともに、軸方向右にΔXだけ移動し停止する。

【００２２】更に、C相の電流制御をA相に切り替え，磁極端３ｂがN極となるように電流を制御する。ロータ９には磁束が増加する方向に力F１が働くので磁極端３ｅに引かれていたロータ９のS極は磁極端３ｂのN極に引かれて磁束の最も多くなる所で停止する。磁極端３ｂは磁極端３ｅよりも時計方向に６０度回転し更に軸方向にΔX右にずれているので、ロータ９は時計方向に６０度回転するとともに、軸方向右にΔXだけ移動し停止する。

【００２３】以上のように励磁する相と励磁極性を順次切替えていくこと（例えばN極を磁極端３ａ→３ｃ→３ｅ→３ｂ→３ｄ→３ｆ→３ａと切替える）により出力軸８はΔXづつ右方向に摺動する。

【００２４】以上とは逆に、出力軸８を左方向に移動させる制御について説明する。今、リニアモータ１のA相の磁極端３ａがN極となるように電流を制御する。ロータ９は着磁されたS極が磁極端３ａのN極に引かれ磁束の最も多くなる所で停止する。次に、A相の電流制御をC相に切り替え、磁極端３ｆはN極となるように電流を制御する。ロータ９には磁束が増加する方向に力F２が働くので磁極端３ａに引かれていたロータ９のS極は磁極端３ｆのN極に引かれて磁束の最も多くなる所で停止する。磁極端３ｆは磁極端３ａよりも反時計方向に６０度回転し更に軸方向左にΔXずれているので、ロータ９は反時計方向に６０度回転するとともに軸方向にΔX左方向に移動する。

【００２５】次いで、C相の電流制御をB相に切り替え，磁極端３ｄがN極となるように電流を制御する。ロータ９には磁束が増加する方向に力F２が働くので磁極端３ｆに引かれていたロータ９のS極が磁極端３ｄのN

極に引かれて磁束の最も多くなる所で停止する。磁極端３ｄは磁極端３ｆよりも反時計方向に６０度回転し更に軸方向に△Ｘ左にずれているので、ロータ９は反時計方向に６０度回転するとともに軸方向左に△Ｘだけ移動する。

【００２６】次いで、Ｂ相の電流制御をＡ相に切り替え，磁極端３ｂがＮ極となるように電流を制御する。ロータ９には磁束が増加する方向に力Ｆ２が働くので磁極端３ｄに引かれていたロータ９のＳ極が磁極端３ｂのＮ極に引かれて磁束の最も多くなる所で停止する。磁極端３ｂは磁極端３ｄよりも反時計方向に６０度回転し更に軸方向に△Ｘ左にずれているので、ロータ９は反時計方向に６０度回転するとともに軸方向左に△Ｘだけ移動する。

【００２７】以上のように励磁する相と励磁磁極を順次切替えていくこと（例えばＮ極を磁極端３ａ→３ｆ→３ｄ→３ｂ→３ｅ→３ｃ→３ａと切替える）により出力軸８は△Ｘづつ左方向に移動する。

【００２８】このように本実施例のリニアモータにおいては、ステータ２の周方向に隣合う各相の磁極３をステータ２の軸方向に△Ｘずれて配置したことで出力軸８をステータ２の軸方向に設けた磁極３のピッチＸよりも細かい移動を出力軸８の軸方向にさせることができる。又、各相の磁極３を軸方向に△Ｘずれて設けたことで磁極３を出力軸８の移動ピッチに対して小さくする必要がないために磁束の大きさは変わらずトルクが落ちることはない。

【００２９】なお、本発明は上記実施例に限定されることはなく、本発明の趣旨から逸脱しない範囲で以下のようにしてもよい。＊

＊（１）上記実施例では３相の励磁コイルを用いたが、２相以上の複数相の励磁コイルとしてもよい。又、図５に示すように各磁極毎に巻着してもよい。

【００３０】（２）上記実施例ではロータの周方向の着磁は円周の１／２ずつで行われているが、円周を複数に分割してＳ極とＮ極を交互に着磁してもよい。又、図６に示すように円周全てをＳ極（又はＮ極）に着磁してもよい。

【００３１】（３）上記実施例ではロータとして円筒状のものを用いたが、円筒以外のもの（例えば外周が六角形状の筒）を用いてもよい。

（４）上記実施例ではロータに円盤形状の複数の永久磁石を用いたが、円筒状の永久磁石で一括形成してもよい。

【００３２】

【発明の効果】以上詳述したように本発明のリニアモータによれば、ステータの内周面に設けた周方向に隣合う各相の磁極が軸方向にずれて配置されたことで、トルクを落とすことなく出力軸の軸方向の移動ピッチを微細化することができるという優れた効果を奏する。

【図面の簡単な説明】

【図１】本発明の実施例を示す縦断面図である。

【図２】本発明の実施例を示す横断面図である。

【図３】ロータの右移動の作用を示す縦断面図である。

【図４】ロータの左移動の作用を示す縦断面図である。

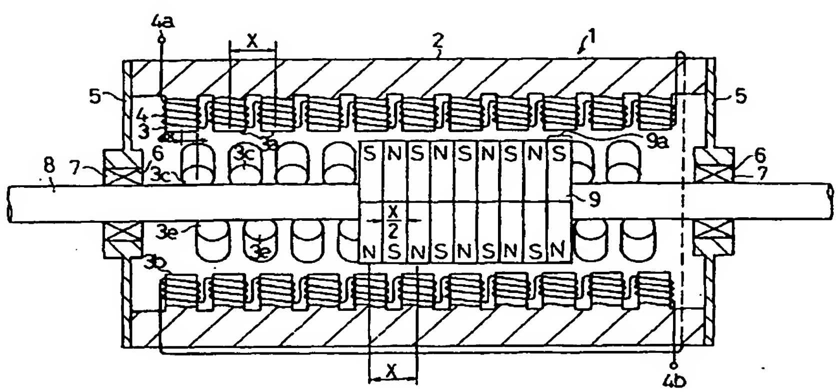
【図５】別例のリニアモータを示す縦断面図である。

【図６】別例のロータを示す斜視図である。

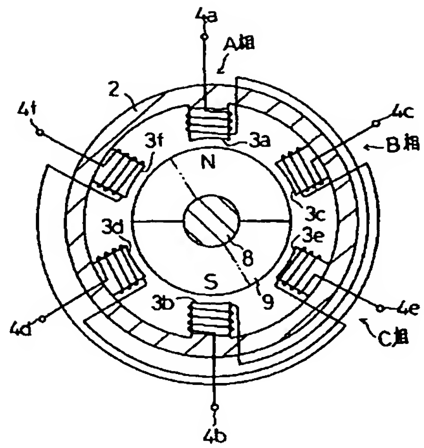
【符号の説明】

１…リニアモータ、２…ステータ、３…磁極、４…励磁コイル、８…出力軸、９…ロータ

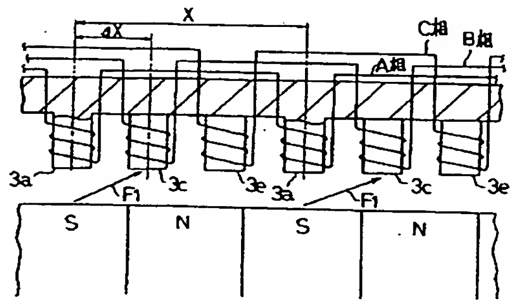
【図１】



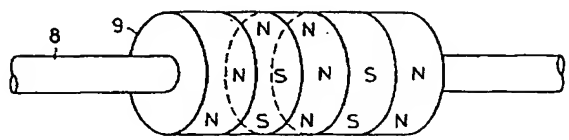
【図2】


4a
A相
2
4f
3f
3a
4c
B相
N
3c
3d
3e
8
S
3b
9
4e
4d
C相
4b

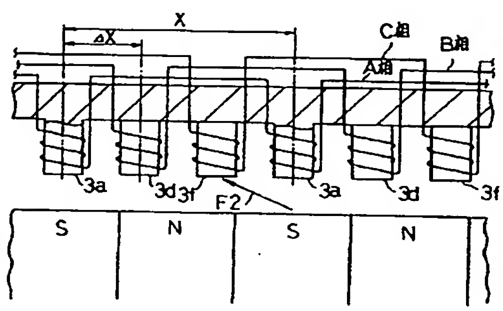
【図3】


X
ΔX
C相
B相
A相
3a
3c
3e
3a
3c
3e
F1
F1
S
N
S
N

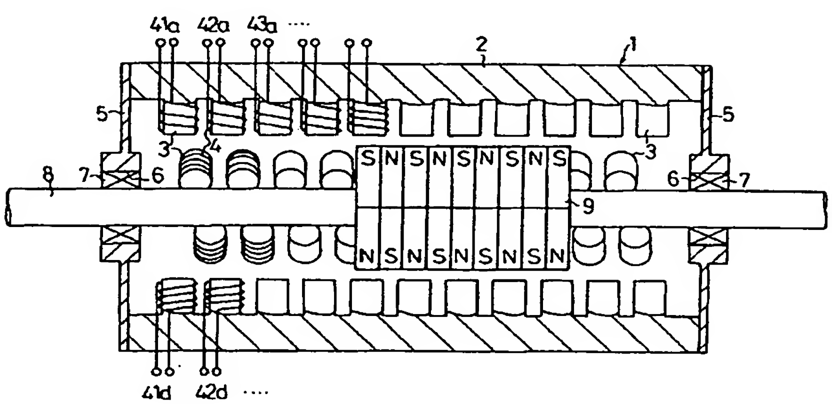
【図6】


8
9
N
N
N
S
N
S
N
N
S
N
S
N

【図4】


X
ΔX
C相
B相
A相
3a
3d
3f
F2
3a
3d
3f
S
N
S
N

【図5】


41a
42a
43a ····
2
1
5
5
3
4
3
8
7
6
S N S N S N S N S
6
7
9
N S N S N S N S N
41d
42d ····